What's in Your Floodplain?

Time

one to two 60-minute period(s)

Vocabulary

100-year flood, channel, dam, erosion, flood, floodplain, habitat, meander, non-point source pollution, point source pollution, pollutant, pollution, reservoir, runoff, sediment, water quality

Objectives

Students will be able to:

- recognize changes in a river from its natural to altered state.
- identify ways pollutants can enter a river through flooding.
- recognize differences between point source and non-point source pollution.

Method

Students will participate in an active game, acting like water molecules and soil particles during a flood.

Materials

colored construction paper (7 colors) cut into small pieces (1- to 2-inch squares work well) or poker chips
large playing area
plastic or paper bags
string, line chalk, or other ways to mark boundaries
Pollutant Information Sheet (one for each student)
Student Directions cut into pieces
paper
writing materials

Background

A year before Captain James Allen's expedition with the Dragoons into northwest Iowa and southwest Minnesota, heavy rains fell. These rains caused rivers to swell out of their banks, onto the surrounding land. This land is referred to as a river's **floodplain**. The Big Sioux, like many of the Missouri River's tributaries, often leaves its typical **channel** (deeper part of a moving body of water where the main current flows) and envelopes its floodplain.

Flooding is any abnormally high stream flow that overtops the banks of a stream. Flooding is a natural process in a river. It creates new channels, wetlands, and oxbow lakes. A floodplain is an integral part of a river system that acts as a **reservoir** (a natural or manmade body of water) and temporary channel for flood waters.

Captain Allen and his crew noted large trees uprooted from the great rains. His report notes the Big Sioux River had "…risen about 17 feet, covering all of its bottom lands five or six feet. Great masses of drift wood had been deposited on its low grounds and timbered bottoms…we followed this river down 159 miles to its mouth, and the rise had been everywhere greater as the stream increased in size. Near its mouth it had partaken of the great rise of the Missouri. And here I noticed water-marks four miles from the Missouri, which I estimated to be at least 25 feet above the ordinary level of that river…" Through various observations, Allen concluded that the greatest rainfall occurred further north than where his crew had traveled.

People have been attracted to floodplains throughout history. The land is fertile (from deposited topsoil), flat, and near water so agriculture, development, and transportation require less effort. Prior to Captain Allen's expedition in 1844, the largest community of people living along the Big Sioux was a village of Native Americans at a site now named Blood Run. Between 1300 and 1750, this site was a major trading location for members of the Oneota Culture including the Omaha, Ioway, Oto, and Yankton Sioux tribes. Approximately 5,000 people lived at this site from 1700-1725, making it the largest known Oneota village in the Midwest. This area encompasses 650-1,250 acres in Iowa, and possibly 1,000 acres in South Dakota.

Today the largest city on the Big Sioux River is Sioux Falls, South Dakota, with about 124,000 people. This city lies in the Big Sioux's floodplain. Despite a flood control system constructed by the Army Corps of Engineers in the 1950s, it has flooded several times in the past 40 years. Its flood control system does not protect the city from a **100-year flood** (a flood having a one in 100 chance of being equaled or exceeded in any given year). Since the system does not protect the city to the Federal Emergency Management Administration's (FEMA) standards, the city is working with the Corps to upgrade its system of levees, spillway, diversion channel, and diversion dam.

Floods are dangerous when they occur and even after the waters have receded. When modern towns flood, numerous chemicals, petroleum products, and effluent may become **pollutants** (substances that may contaminate air, water, or soil). **Pollution** (contamination of soil, water, or air by harmful substances) can be divided into two groups: point source and non-point source. **Point source pollution** occurs when a pollutant can be traced back to the point of origin. For example, when a sewage treatment plant has a leak the sewage can be traced back to the plant. **Non-point source pollution** occurs when a pollutant cannot be traced back to its point of origin. Many times we see the results before we know there is a problem. An example of this would be **runoff** (water that drains or flows off the surface of the land) full of silt from a field or construction area.

While flooding is a natural process, there are ways to reduce the magnitude of floods and the amount of pollution entering waterways. Wetlands act as natural sponges, absorbing water and filtering out pollutants before reaching a body of water, so wetlands reduce the amount of water and pollutants that reach rivers and streams. Grass waterways slow runoff and absorb water before it reaches a stream or river. Levees, dikes, and **dams** (barriers preventing flow of water) may keep the water in the main channel, but they are costly to construct, remove **habitat** (arrangement of food, water, shelter or cover, and space suitable to animals' needs) for wildlife, and increase the risk of downstream flooding.

We also can reduce the amount of pollutants entering bodies of water. Good conservation practices in fields and developed areas keep soil, fertilizers, pesticides, and other chemicals out of our waters. Reducing or eliminating construction in the 100-year floodplain reduces damage from floods and prevents pollutants from these areas from entering rivers and streams.

For more information on Captain James Allen's journey, refer to *Iowa's Water,* page 4.

Procedure

1. Share *background information* on floodplains, pollutants, and Captain James Allen's journey through northwest Iowa.
2. Assign a pollutant from the *Pollution Information Sheet* to each color of construction paper. Make sure you have a lot of "**sediment**" (fine soil and other particles that settle to the bottom of a liquid) and an increased number of "fertilizer" and "manure."

3. Mark off a 10-foot wide section across the playing area. This will be the Big Sioux River. Make the river **meander** (S-shaped). Mark off 10 feet on both sides of the river. This will be the 100-year floodplain. Mark two smaller "tributaries" at one end of the river. The water will flow away from the tributaries into the Missouri River (the end of the Big Sioux). Place half of the "sediment," and a small amount of "sewage" on and near the river and tributaries' banks and floodplain.
4. Inform students they will be acting like water molecules. Explain the playing area and the areas marked.
5. Handout the cut *Student Directions* (one per student), make additional copies if needed.
6. Have students read their directions and move to their designated starting places. When you say "River Flow!" the game starts with the students, designated as water molecules in the river or tributary, walking through their respective channel. When all river/tributary molecules have made it to the Missouri River, explain to the students this is what the Big Sioux was like when Captain James Allen explored the area. The River meandered and was within its banks. Ask how many people picked up pieces of construction paper. Record the number of pieces picked up on a sheet of paper. Inform students what the two different colors represent. **Erosion** (removal or wearing away of soil or rock by water, wind, or other forces or processes) and sewage (animal & human waste) occurred long before Allen explored the area.
7. Gather the pieces of construction paper from the students and place throughout the playing area.
8. Have the river/tributary water molecules resume their starting positions. When you say "Flood!" students should follow the directions on their piece of paper. There should not be enough pieces of construction paper for everyone. When all molecules have reached the Missouri River, part one of the game is finished. Explain to the students this is what the Big Sioux used to look like (when Allen explored the area) when it flooded. The river expanded out of its banks enveloping the floodplain. Ask how many people picked up pieces of construction paper. Record the number of pieces picked up on the sheet of paper. Review the representation of the different colors. There were not enough pieces of construction paper, because the vegetation throughout the floodplain held the soil in place, animal wastes decomposed, and nutrients were used by the plants.
9. Gather all pieces of construction paper and have students trade their directions. Explain to them that they will represent what the Big Sioux looks like today. Straighten the boundaries of the Big Sioux River and the tributaries. Add the remaining pieces of construction paper in the floodplain. Be creative; place pollutants in "clusters" to represent contaminants that might come from cities and/or farms, etc. Describe what you are doing, while you are doing it.
10. Have students read their directions and move to their designated starting places. When you say "River Flow!" the game resumes with the students designated as river or tributary water molecules moving through their respective channel. When all molecules are in the Missouri River, explain to the students this is what the Big Sioux River looks like now with normal water flow. Ask how many students picked up pieces of construction paper. Record the number of pieces picked up on the sheet of paper. Explain the representation of each color. Define point source and non-point source pollution and list which pollutants are which.
11. Have the river/tributary water molecules return to their starting positions. When you say "Flood!" students should follow directions on their piece of paper. When all water molecules have reached the Missouri River, part two of the game is finished. Explain to the students that this is what happens when the Big Sioux floods today. The River expands its banks and envelops the floodplain. Ask how many people picked up pieces of construction paper. Record the number on the sheet of paper. Review the representation of each color. Review point source and non-point source pollution and list which pollutants are which.

12. Hand out *Pollutant Information Sheet*.
13. Have students brainstorm or research ways to prevent pollution and reduce the impacts of floods.

Evaluation

Discuss the following:

1. What was the Big Sioux like when Captain Allen traveled it? (meandering, braided streams, backwaters, sloughs)
2. What is the Big Sioux like now? (portions are channelized, one channel, flood control structures, development of the floodplain for cities, farming, etc.)
3. What happens as water flows downstream? (Water picks up sediment and other pollutants)
4. What happens when a river floods?
5. Did more pollutants enter the river during the flood or during normal flow? Why?
6. What is point source pollution? What is non-point source pollution?
7. What are some types of pollutants?
8. How have people impacted the **water quality** (condition of water) of the Big Sioux River?
9. What are some ways to prevent pollutants from entering waterways?
10. What are some ways to reduce flooding?

Extensions

Demonstrate non-point source pollution and point source pollution by borrowing an EnviroScape® model. For a list of places that have an EnviroScape® for loan, or for more information, check out the DNR web site (www.iowadnr.gov/education/envloc.html), or call the Aquatic Education Program (641/747-2200).

Borrow a stream table to demonstrate floods, watersheds and channelized and meandering streams. Contact the DNR Aquatic Education Program for a list of sites with stream tables for loan, or visit www.iowadnr.gov/education/strtabloc.html.

Research what explorers visited your area and modify the activity to represent a local river.

Teacher Aids

Posters:

"Aquatic Life." Ill. Brian Wignall. 1989. Des Moines: Iowa Department of Natural Resources' Aquatic Education Program.

"Life in a Stream." Ill. Brian Wignall. 1989. Des Moines: Iowa Department of Natural Resources' Aquatic Education Program.

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"Biodiversity of Iowa: Aquatic Habitats." 2001. Des Moines: Iowa Department of Natural Resources' Aquatic Education Program.

"Canaries of the Deep, The Plight of the Fresh Water Mussel." 2003. Geode Resource Conservation and Development Incorporated.

Student Directions

Tributary Water Molecule
Begin at the top of a tributary.
When you hear "Water Flow!" walk ***within*** the banks of your tributary and the Big Sioux River to the Missouri River.
When you hear "Flood!" walk quickly ***within*** the banks of your tributary and the Big Sioux River to the Missouri River.

Tributary Water Molecule
Begin at the top of a tributary.
When you hear "Water Flow!" walk ***within*** the banks of your tributary and the Big Sioux River to the Missouri River. Collect 3 pieces of construction paper on your way.
When you hear "Flood!" walk quickly ***within*** the banks of your tributary and the Big Sioux River to the Missouri River. Collect 5 pieces of construction paper on your way.

Tributary Water Molecule
Begin at the top of a tributary.
When you hear "Water Flow!" walk ***within*** the banks of your tributary and the Big Sioux River to the Missouri River. Collect 1 piece of construction paper on your way.
When you hear "Flood!" walk quickly ***inside*** the banks of your tributary and ***outside*** the banks of the Big Sioux River to the Missouri River. Collect 4 pieces of construction paper on your way.

Tributary Water Molecule
Begin at the top of a tributary.
When you hear "Water Flow!" walk ***within*** the banks of your tributary and the Big Sioux River to the Missouri River. Collect 1 piece of construction paper on your way.
When you hear "Flood!" walk quickly ***inside*** the banks of your tributary and ***outside*** the banks of the Big Sioux River to the Missouri River. Collect 2 pieces of construction paper on your way.

River Water Molecule
Begin at the start of the Big Sioux River.
When you hear "Water Flow!" walk ***inside*** the banks of the Big Sioux River to the Missouri River.
When you hear "Flood!" walk quickly ***inside*** the banks of the Big Sioux River to the Missouri River. Collect 5 pieces of construction paper.

River Water Molecule
Begin at the start of the Big Sioux River.
When you hear "Water Flow!" walk ***inside*** the banks of the Big Sioux River to the Missouri River.
When you hear "Flood!" walk quickly ***inside*** the banks of the Big Sioux River to the Missouri River. Collect 2 pieces of construction paper.

River Water Molecule
Begin at the start of the Big Sioux River.
When you hear “Water Flow!” walk ***inside*** the banks of the Big Sioux River to the Missouri River.
Collect 1 piece of construction paper.
When you hear “Flood!” walk quickly ***inside*** the banks of the Big Sioux River to the Missouri River.

River Water Molecule
Begin at the start of the Big Sioux River.
When you hear “Water Flow!” walk ***inside*** the banks of the Big Sioux River to the Missouri River.
Collect 1 piece of construction paper.
When you hear “Flood!” walk quickly ***outside*** the banks of the Big Sioux River to the Missouri River.

River Water Molecule
Begin at the start of the Big Sioux River.
When you hear “Water Flow!” walk ***inside*** the banks of the Big Sioux River to the Missouri River.
Collect 2 pieces of construction paper.
When you hear “Flood!” walk quickly ***outside*** the banks of the Big Sioux River to the Missouri River. Collect 4 pieces of construction paper.

River Water Molecule
Start at the beginning of the Big Sioux River.
When you hear “Water Flow!” walk ***inside*** the banks of the Big Sioux River to the Missouri River.
When you hear “Flood!” walk ***outside*** the banks of the Big Sioux River to the Missouri River.

River Water Molecule
Start at the beginning of the Big Sioux River.
When you hear “Water Flow!” walk ***inside*** the banks of the Big Sioux River to the Missouri River.
When you hear “Flood!” walk ***outside*** the banks of the Big Sioux River to the Missouri River.

Rain Molecule
Begin at the top of the Big Sioux River.
When you hear “Water Flow!” do nothing.
When you hear “Flood!” walk quickly ***inside*** the banks of the Big Sioux River to the Missouri River.
Collect 2 pieces of construction paper on your way.

Rain Molecule
Begin at the top of the Big Sioux River.
When you hear “Water Flow!” do nothing.
When you hear “Flood!” walk quickly ***outside*** the banks of the Big Sioux River to the Missouri River. Collect 2 pieces of construction paper on your way.

Rain Molecule
Begin at the top of the Big Sioux River.
When you hear "Water Flow!" do nothing.
When you hear "Flood!" walk quickly ***outside*** the banks of the Big Sioux River to the Missouri River.

Rain Molecule
Begin at the top of a tributary.
When you hear "Water Flow!" do nothing.
When you hear "Flood!" walk quickly ***inside*** the banks of your tributary and ***outside*** the banks of the Big Sioux River to the Missouri River. Collect 3 pieces of construction paper on your way.

Rain Molecule
Begin at the top of a tributary.
When you hear "Water Flow!" do nothing.
When you hear "Flood!" walk quickly ***inside*** the banks of your tributary and ***outside*** the banks of the Big Sioux River to the Missouri River. Collect 2 pieces of construction paper on your way.

Rain Molecule
Begin 2 paces from the middle of the Big Sioux River.
When you hear "Water Flow!" do nothing.
When you hear "Flood!" walk quickly ***outside*** the banks of the Big Sioux River to the Missouri River. Collect 2 pieces of construction paper on your way.

Rain Molecule
Begin 2 paces from the middle of the Big Sioux River.
When you hear "Water Flow!" do nothing.
When you hear "Flood!" walk quickly ***outside*** the banks of the Big Sioux River to the Missouri River. Collect 1 piece of construction paper on your way.

Pollutant Information Sheet

Sediments

Particles of soils, sand, silt, clay, and minerals wash from land and paved areas into creeks and tributaries. In large unnatural quantities, these natural materials can be considered pollutants. Construction projects often contribute large amounts of sediment. Sediments may fill stream channels that later require dredging. Sediments suffocate fish and shellfish populations by covering fish nests and clogging the gills of bottom fish and shellfish. This is often a non-point source pollutant.

Human and Animal Waste

Human waste that is not properly treated at a waste treatment plant and then released into water may contain harmful bacteria and viruses. Typhoid fever, polio, cholera, dysentery, hepatitis, flu, and common cold germs are examples of diseases caused by bacteria and viruses in contaminated water. The main source of the problem is sewage getting into the water. People can come into contact with these micro-organisms by drinking the polluted water or through swimming, fishing, or eating shellfish living in polluted waters. Often unexpected flooding of barnyards, stock pens, or holding tanks can suddenly increase the toxic effects of animal waste in water. Animal waste can also act as a fertilizer and create damage by increasing nutrients. This is commonly a non-point source pollutant.

Detergents and Fertilizers

Many of these substances are toxic to fish and harmful to humans. They cause taste and odor problems and often cannot be treated effectively. Some are very poisonous at low concentrations. The major source of pollution from agriculture comes from surplus fertilizers in the runoff. Fertilizers contain nitrogen and phosphorus that can cause large amounts of algae to grow. The large algae blooms cover the water's surface. Once dead, they sink to the bottom where bacteria feed on them. The bacterial populations increase and use up most of the oxygen in the water. Once the free oxygen is gone, many aquatic animals die. This process is called "eutrophication." This is typically non-point source pollution.

Pesticides, Herbicides, and Fungicides

Chemicals that are designed to limit the growth of or kill life forms are a common form of pollution. This pollution results from the attempts to limit the negative effects of undesirable species on agricultural crop production. Irrigation, ground-water flow, and natural runoff bring such toxic substances to rivers, streams, and lakes. This is typically non-point source pollution.

Organic Waste

Domestic sewage treatment plants, food-processing plants, paper mill plants, and leather tanning factories release organic wastes that bacteria consume. If too much waste is released, the bacterial populations increase and use up the oxygen in the water. Fish die if too much oxygen is consumed by decomposing matter. This is commonly a point-source pollutant.

Inorganic Chemicals

Inorganic chemicals and mineral substances, solid matter, and metal salts commonly dissolve in water. They often come from mining and manufacturing industries, oil field operations, agriculture, and natural sources. Those chemicals interfere with natural stream purification; they destroy fish and other aquatic life. They also corrode expensive water treatment equipment and increase the amount of boat maintenance. This is commonly a point-source pollutant.

Petroleum Products

Oil and other petroleum products such as gasoline and kerosene can enter water from boats, automobile service stations, and streets. Oil spills kill aquatic life (fish, birds, shellfish, vegetation). Birds are unable to fly when oil loads their feathers. Shellfish and small fish are poisoned. If it is washed on the beach, oil requires much labor to clean up. Fuel oil, gasoline, and kerosene may leak into ground water through damaged underground storage tanks. This is often a non-point source pollutant, but may be a point source if in the form of a large oil spill.